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CAN PRESENT CLASSES OF PIPE BE REDUCED BY A MATERIAL INCREASE IN THE STRENGTH OF THE METAL?[1]

W. W. **Brush**:[2] The question under discussion is whether an increase of, say, 50 per cent in the strength of the metal of which cast iron pipe is made will probably result in a reduction being made in the number of classes of pipe that are now scheduled in the standards adopted by the American Water Works Association. These standards are placed in two groups, the first group representing pipe suitable for a head of from 100 to 400 feet, and second group, known as high-pressure pipe, covering heads from 500 up to 800 feet. The first group is that which is used for almost all the pipe placed in distribution systems.

The more important question will, then, be whether there can reasonably be omitted any of the present four classes that appear in this group. The answer that ultimately will be given to this question will be based upon the economic advantages or disadvantages that will result to the purchaser from the elimination of any of the present classes. An increase of 50 per cent in the strength of the pipe would make a reduction in the present difference in weight between the various classes, but this reduction would not be directly proportionate to the increase in weight, as cast iron pipe has generally an allowance of $\frac{1}{4}$ inch in thickness to provide for the weakening effect of corrosion, and such allowance would logically not be affected by any modification in the strength of the metal. If the metal were to show a higher resistance to corrosion, as a result of the change which increased the strength of the metal, then this $\frac{1}{4}$ inch allowance might be reduced, but from our knowledge of the relative rapidity of corrosion of cast iron and steel, it seems most unlikely that iron of a higher tensile strength will offer an increased resistance to corrosion.

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[1] Informal discussion at a meeting of the New York Section, October 22, 1919. Further discussions are requested, and should be sent to the Editor.

[2] Deputy Chief Engineer, Department of Water Supply, Gas and Electricity, New York, N. Y.

A tabulation has been made of the percentage that the weights of classes A, B, and D bear to class C, for the various sizes of pipe from 4 inches up to 60 inches in diameter. Class C is used as the unit of comparison, as this pipe, which is designed for a 300-foot head, is the class which would be suitable for the vast majority of distribution systems, assuming that the lighter classes were to be discontinued. It is interesting to note that this comparison shows class A pipe 4 inches in diameter to be 14 per cent less in weight than the similar size class C pipe. This difference in weight increases as the size of the pipe increases, until a difference of 32 per cent is noted for 60-inch pipe.

It is very doubtful whether those who find class A pipe adequate for their needs will be willing to pay the above additional percentage for class C pipe, and it is also doubtful whether the manufacturer would make a sufficiently attractive price on class C pipe to offset any substantial part of this difference in percentage.

Class B pipe shows 7 per cent lower weight for 4-inch pipe, which increases to 18 per cent lower weight for 60-inch pipe. Here again the percentages are substantial, and are virtually the same numerically as those shown for class D pipe. In the high pressure pipe, the variations are very similar to those set forth in the low pressure pipe.

It is the speaker's conclusion that the present classes of pipe, which are designed for variations in head of 100 feet for each class, represent as small a number of classes as the water supply fraternity would be willing to subscribe to, and that no change is to be expected unless the manufacturers can clearly show that a change can be made with a resultant reduction in price of the different pipe to the consumer.

R. W. Conard:[3] The present specifications for cast iron pipe are based on iron that is presumed to have a tensile strength of 20,000 pounds, but as a matter of fact most of the iron that is going into pipes today is of slightly greater strength, running up to possibly 24,000 pounds. When higher standards are given with present foundry mixtures and methods, the elasticity of the iron in pipe is reduced and it becomes harder and more brittle. Probably the question under discussion arose because some manufacturers have been making experiments on high tensile metal. These investiga-

[3] Inspecting Engineer, Burlington, N. J.

tions are understood to involve some method whereby they can produce a pipe which has an elasticity as great as the present iron pipe. There has been, within recent years, pipe produced that has had a higher strength than the present standard, for which probably an extra charge was made.

Iron of greater strength and elasticity than is now used can be put in pipes for about 10 or possibly 5 per cent increase in price. It might be worth giving this consideration, when looked at from that standpoint. There is being consideration given to the question of some possible revision in the specifications for standard cast iron pipe, and the information that might be gathered from a thorough discussion of this question would undoubtedly be of value to the committees that are working on the revision of these specifications.

H. F. DUNHAM:[4] Unless Mr. Brush has taken into consideration the factors of safety that now obtain in cast iron pipes under specifications that originated largely in the manufacturer's department of this Association, and were named largely by the Association itself, this item or these factors should receive attention.

This suggestion is not entirely new. Years ago, the speaker prepared a table for the different sizes and classes of pipe. Care was taken to avoid confusion resulting from the necessity of making small sizes of a thickness suitable for desirable house connections. If a thickness of wall of 0.42 inch is suitable for 4-inch pipe connections there could be no trouble from a connection with a 12-inch pipe with walls of the same thickness. Therefore the investigation was limited to the larger sizes; twelve inches and above.

Now it would be naturally supposed that with increase in size and in pressure the factor of safety should be also increased. Certainly there would be greater losses in event of failure. But the truth is that in the so-called American Water Works Standard Specification the lesser sizes under the lower pressure have by far the greater factor of safety. For the 12-inch pipe the factors under the different classes range from about 30 for the low heads to about 12 for the high heads and for some of the still larger sizes and high heads the factor is as low as 9. This is all on a basis of 18,000 pounds for tensile strength of cast iron and corrected for a proper reduction in the thickness of the wall of the pipe on account of the variations due to irregularities in core or castings.

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[4] Consulting Civil Engineer, 32 West 40th Street, New York, N. Y.

Manufacturers and their salesmen often claim advantags for thick-wall pipe on account of the diminished chance for fractures in the trench after the pipe has been laid. But every superintendent knows that the heaviest pipe can be so laid as to break down under the laws of gravitation and that lighter pipe can be so laid as to be permanent under the same laws. Moreover, for extreme conditions, as where the adjacent earth is liable to be disturbed, special provision can be made. It is not necessary that half a mile of difficult ground should determine the weight of a 40-mile pipe system.

The point to be considered is this: if you are to introduce a superior grade of metal, like semi-steel, with new factors of safety, present factors will be changed and should bear a proper instead of an improper relation to each other. They should be changed in any event.

W. W. BRUSH:[2] The question raised by Mr. Dunham of factors of safety in the present standards is one in which we are all interested, but is one about which there is a difference of opinion among water works men. Mr. Dunham directs attention to the reduction in the factor of safety as the diameter of the pipe increases. It is generally considered that the greater relative thickness of pipe wall for the smaller size pipe is desirable and probably necessary to avoid danger of fracturing pipe while it is being handled prior to the laying of the pipe. Also that the water hammer is likely to reduce as the size of the pipe increases.

Theoretically there should not be some of the differences in thickness which now appear for the pipes of the different diameters, and the variations in thickness between classes is comparatively small when one considers the large factor of safety. The speaker has been interested in noting that the reasonableness of the difference in thickness for the different classes has been apparently sustained by the experience in New York City, where a larger percentage of breaks on 20-inch pipe than on other size has been noted after the introduction of higher pressures, and the previous New York City standard for 20-inch pipe is relatively the lightest of the various diameters in use.

There appears to be general satisfaction secured when pipe is used of the standard thickness recommended for various heads by the American Water Works Association, and unless it is conclusively shown that these standards are illogical, it would, in the speaker's opinion, be inadvisable to attempt to change them.